Remarks

This is in response to the Office Action mailed December 1, 2005, in the above-referenced application. The rejections of record are addressed below in the order presented in the Office Action.

The Office argues that the term "a desired amount" in Claims 1 and 15 renders the claims indefinite and appears to require recitation of a "specific percentage" of crystal growth. Applicants respectfully traverse this rejection and submit that Claims 1 and 15 are definite.

The essential inquiry pertaining to this requirement is whether the claims set out and circumscribe a particular subject matter with a reasonable degree of clarity and particularity. Definiteness of claim language must be analyzed, not in a vacuum, but in light of the content of the particular application disclosure; the teachings of the prior art; and the claim interpretation that would be given by one possessing the ordinary level of skill in the pertinent art at the time the invention was made. In this case, one of ordinary skill in the art could readily determine from the written disclosure what a "desired" amount of crystal growth is. Further, the skilled artisan would readily understand and appreciate what the parameters for a "desired amount" of crystal growth would be for a given application. Applicants accordingly respectfully request withdrawal of this rejection.

Claims 1-42 are rejected as unpatentable under 35 USC § 103 over U.S. Patent No. 6,218,680 to Carter, jr. et al. Applicants respectfully traverse this rejection.

By way of background, a recurring issue in the fabrication of silicon carbide crystals for electronic devices is control of elemental impurities such as nitrogen within the crystal, which can affect crystal color and electrical conductivity. Various techniques have been proposed to control nitrogen content of silicon carbide crystals, including back filling a crystal growth chamber with argon and minimizing nitrogen content of the equipment employed for crystal growth. Other proposed techniques include nitrogen compensation, which can include the introduction of an acceptor dopant, such as boron,

into the crystal. Despite the usefulness of such techniques, they can often require additional processing steps and decrease control of the resultant crystal properties.

In contrast to prior techniques, the present invention can control nitrogen content by maintaining an ambient concentration of hydrogen in the growth chamber sufficient to minimize the amount of nitrogen incorporated into the growing silicon carbide crystal. In this way, the present invention can provide control of the nitrogen content from the initial growth of the crystal. The present invention can further help minimize the need for compensation techniques and associated process steps. The present invention may also permit selective tuning of nitrogen content of the growing crystal, thereby allowing the development of diverse types of crystals, including crystals with varying degrees of nitrogen content for specialized purposes.

The Office admits that the '680 patent does not "exactly" teach the use of a hydrogen ambient to control nitrogen content of a silicon carbide crystal. Applicants respectfully note that the '680 patent nowhere teaches the use of a hydrogen ambient.

In contrast to the claimed invention, the '680 patent reduces nitrogen content by starting with high purity materials and also by using higher temperatures. See Column 6, lines 21-33. The '680 patent apparently addresses the problem of nitrogen content in this way (controlling purity of starting materials and temperature), and is silent with respect to modifying other process conditions. The '680 patent certainly does not identify growth chamber atmosphere as an issue and thus cannot teach or suggest modifying growth chamber ambient, much less teach or suggest the use of a hydrogen ambient to control nitrogen content. Accordingly, there is no motivation to modify the method of the '680 patent, absent an improper hindsight reliance on the Applicants' own teachings.

In addition, the present application includes comparative data demonstrating significantly reduced nitrogen content in a crystal using a hydrogen ambient atmosphere, in contrast to a traditional argon ambient atmosphere. The Examiner's attention is directed to Figures 1 and 2, which illustrate that the claimed invention presents a

significant advancement in the field of growing highly pure, semi-insulating silicon carbide crystals by sublimation.

Figures 1 and 2 plot the photoluminescence spectra for silicon carbide crystals and show luminescent intensity peaks at specific wavelengths. These peaks of luminescence are proportionally related to the nitrogen content of the silicon carbide crystal under consideration. As discussed in the present application at paragraphs [0043] – [0047], the figures plot the relative luminescence intensity versus wavelength for 4H silicon carbide crystals. The peak luminescence intensity is shown as Q_0 and corresponds to the intensity of an electron-hole recombination bound to a nitrogen atom as an impurity in the crystal. Less intense peaks of luminescence in the figures correspond to phonon coupled recombinations, the most significant of which for purposes herein is the recombination marked I_{75}. I_{75} is the highest intensity phonon-assisted recombination and can be identified by its asymmetric line shape. As known to those in the art, the ratio of Q_0 to I_{75} yields a constant that can be used to extrapolate the nitrogen content of the subject silicon carbide crystal.

Figure 1 shows the low temperature photoluminescence spectrum corresponding to a 4H-silicon carbide crystal grown by sublimation in a conventional argon ambient. Figure 1 is, therefore, indicative of prior art in the area of silicon carbide grown by sublimation. The extrapolated nitrogen content is approximately 3×10^{15} nitrogen atoms per cubic centimeter of the resulting silicon carbide crystal.

Figure 2 shows the low temperature photoluminescence spectrum corresponding to a 4H-silicon carbide crystal grown in a hydrogen ambient according to the claimed invention. As can be seen in the spectrum, the ratio of Q_0 to I_{75} is at 0.6, corresponding to a nitrogen concentration in the crystal of 3×10^{14} nitrogen atoms per cubic centimeter. The data of Figure 2 shows that the presence of a hydrogen ambient in the sublimation growth chamber reduced the nitrogen content in the crystal by approximately one order of magnitude. Figure 2 shows, therefore, that the hydrogen concentration in the growth chamber ambient can be used to reduce the nitrogen content of the resulting silicon

carbide crystal grown therein. The resulting low nitrogen crystal is a high purity semi-insulating crystal as desired.

In summary, Applicants respectfully submit that the Office fails to present a prima facie case of obviousness. The '680 patent does not teach or suggest modifying process conditions such as growth chamber ambient and certainly does not teach or suggest the use of a hydrogen ambient. There is no motivation to modify the teachings of the '680 patent, absent an improper hindsight reliance on Applicants' own specification. In addition, the application includes comparative data demonstrating unexpected benefits of the claimed invention, namely a reduction of nitrogen content in the resultant silicon carbide crystal by approximately one order of magnitude. Accordingly, Applicants submit that the claimed invention is patentable over the '680 patent and respectfully request withdrawal of this rejection.

The rejections of record having been addressed in full in the foregoing, Applicants respectfully submit that the present application is in condition for allowance, which action is respectfully solicited. Should the Examiner have any questions regarding the foregoing, it is respectfully requested that the Examiner contact eh undersigned at his convenience to assist in expediting prosecution of this matter.

It is not believed that extensions of time or fees for net addition of claims are required beyond those that may otherwise be provided for in documents accompanying this paper. However, in the event that additional extensions of time are necessary to allow consideration of this paper, such extensions are hereby petitioned under

37 CFR § 1.136(a), and any fee required therefore (including fees for net addition of claims) is hereby authorized to be charged to Deposit Account No. 50-0332.

Respectfully submitted,

Melissa B. Pendleton
Reg. No. 35,459

021176
Summa, Allan & Additon, P.A.
11610 N. Community House Rd., Suite 200
Ballantyne Corporate Park
Charlotte, North Carolina 28277-2162
Telephone: 704-945-6700
Facsimile: 704-945-6735
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